CALIFORNIA DIVISION OF MINES AND GEOLOGY
FAULT EVALUATION REPORT FER-234
SUPPLEMENT No. 1

JOHNSON VALLEY, KICKAPOO, HOMESTEAD VALLEY, AND RELATED FAULTS SAN BERNARDINO COUNTY

by
William A. Bryant
May 27, 1993

INTRODUCTION

Surface fault rupture associated with the Johnson Valley, Kickapoo, Homestead, and related faults was associated with the June 28, 1992 M_S 7.5 Landers earthquake. These faults have been described by Bryant (1992) and Alquist-Priolo Special Studies Zones have been recommended in the Landers and Yucca Valley North quadrangles (CDMG, 1993a, 1993b). The purpose of this supplement is to consider new data which has come to our attention since the release of the Preliminary SSZ maps on January 1, 1993. Additional rupture has been identified and mapped along strands of the Kickapoo fault, and minor fractures have been identified along strands of the Johnson Valley, Homestead Valley, and related faults. These new data may warrant revision of the preliminary SSZ maps of the Landers and Yucca Valley North quadrangles (CDMG, 1993).

NEW INFORMATION

LETTIS AND ASSOCIATES

William Lettis and Associates (1993) provided DMG with a 1:6,000 scale map based on detailed field observations and aerial photographic interpretation of 1:6,000 scale I.K. Curtis aerial photographs (taken 6-30-92) and 1:4,000 scale I.K. Curtis photos (taken late August 1992) of fault rupture in the area of the step-over between the Johnson Valley and Homestead Valley faults. Fractures mapped by Lettis and Associates are highlighted in yellow on Figure 1. Most of the traces mapped by DMG and USGS, and zoned for special studies on the Landers quadrangle, were verified by Lettis and Associates, but some of the complex rupture in the broad step-over zone between the Johnson Valley and Kickapoo faults was not originally mapped and zoned (e.g., localities A and B, Figure 1).

I checked selected rupture areas using the 1:6,000 and 1:4,000 scale Curtis air photos in order to verify the overall quality of mapping. No field checking was done. It was not my intent to attempt to verify every rupture mapped by Lettis and Associates, but rather to: 1) confirm the presence of most fractures in the selected areas checked and 2) to verify the accuracy of plotting. Those areas photo checked are indicated by a check mark (i.e. locality A, Figure 1). Both the presence of fractures and the accuracy of plotting in these selected areas generally were verified.

RASMUSSEN AND ASSOCIATES

Additional fractures mapped by Gary Rasmussen and Associates (1993) are located in the Landers and Yucca Valley North quadrangles (Figures 2a-2e). Some of the fractures shown by Rasmussen and Associates were evaluated in Bryant 1992 (FER-234) and not recommended for zoning (i.e. locality C, Figure 2c). The description of the fracture at locality C is excerpted from Bryant 1992. "A sinuous west-facing scarplet extended for about 210 meters north of University Road at locality C (Figure 2c). The 5 cm high scarplet, which was identified as a reverse or thrust fault by F. Jordan, is located at or within about 1 meter of the toe of the slope and is in loose, fine to medium grained sand. Several hand-dug pits were excavated across this scarplet. No fault planes were associated with this scarplet, which in loose granular alluvium is not surprising. A feature common in all of the excavations was the overriding of the "upper plate" over the "lower plate" (indicated by a dry grass mat separating the upper and lower plates). A distinctive silt horizon observed in one excavation was not displaced.

"A probable explanation for this sinuous scarplet is as follows. A debris flow (sand flow) occurred in the past prior to the Landers earthquake, as indicated by a thin organic mat underlying the upper silty sand unit (Figure 6 [to FER-234]). This organic layer represented the talus surface prior to the sand flow. Shaking from the Landers earthquake caused the material in the talus to flow to the west an additional 10 to 20 cm, overriding dry grass growing on the now buried surface. This explanation is thought to be consistent with the observations because: (1) no displacement of a distinctive slit layer was observed in one excavation, and (2) the 10 to 20 cm length that the "upper plate" overrode the "lower plate" seems inconsistent with a thrust fault in such cohesionless material."

Rasmussen and Associates mapped a northeast trending fracture on the Johnson Valley fault in the Flamingo Heights area (locality E, Figure 2a). I verified the location of this fault rupture, although his trace is somewhat generalized (see my interpretation in inset of Figure 2a). A fracture with about 6 mm of right-lateral displacement extended south of zoned traces of the Johnson Valley fault at locality F (Figure 2b). I verified the fractures in the paved road, based on air photo interpretation, but the location of Rasmussen and Associates is too far to the east by about 30 meters (100 feet).

The fractures at locality D (Figure 2e) offset the road centerline about 3cm right-laterally and were mapped for a short distance to the north and south (F. Jordan, p.c., May 1993). The extent of the fractures is not known beyond the area mapped by Jordan. I field checked this location in November 1992, but the road had been repaired and fractures no longer exist in the immediate vicinity of the road.

An additional northeast-trending fracture in Fault Zone A also was observed by Rasmussen and Associates (Figure 2a). This fracture was not verified on the 1:6,000 scale Curtis air photos, but the generally east-facing scarps delineating ruptures in Fault Zone A usually cannot be seen in these flight lines.

Fractures in the Pipes Wash area were reported by K. Umbarger and evaluated in FER-234. Additional fractures mapped by Rasmussen and Associates lie between the Homestead Valley fault and those ruptures associated with the 1979 Homestead Valley earthquake that were zoned for special studies in 1988 (Figure 2c). These fractures were not verified because photo coverage is not available in this area. However, F. Jordan (p.c. May 1993) indicated that these fractures were not accurately

located, existed only in older alluvium, were extensional, and generally were parallel and did not form en echelon patterns. Rasmussen and Associates also indicate that the Homestead Valley fault may have ruptured discontinuously southwest of the 1979 ruptures (locality G , Figure 2c), but again the locations are only approximate (F. Jordan, p.c. May 1993).

CONCLUSIONS

Surface fault rupture along the Kickapoo fault associated with the Landers earthquake formed an extremely complex pattern of deformation, transferring strain across Homestead Valley from the Johnson Valley fault to the Homestead Valley fault. Post earthquake mapping by Lettis and Associates (1993) concentrated in this step-over area and fills in some of the apparent gaps in the rupture pattern along branches of the Kickapoo fault. The mapping by Lettis and Associates, where photo-checked by this writer, is accurate. Because of time constraints, the lack of field checking, the amount of time since the earthquake, and the apparent quality of mapping by Lettis and Associates, all of the traces mapped by Lettis and Associates shown on Figure 1 should be used to revise the Special Studies Zones map of the Landers quadrangle.

Fractures mapped by Rasmussen and Associates along the Johnson Valley fault (locality E, Figure 2a) were verified and should be added to the SSZ Map of the Yucca Valley North quadrangle, as should the northeast-trending fracture in Fault Zone A. The fractures reported at locality D (Figure 2e) also should be added to the SSZ Map of the Landers quadrangle. The origin of the fractures between the Homestead Valley fault and ruptures formed in 1979 is not clear and the locations shown by Rasmussen and Associates are only approximate. Therefore, these fractures should not be included in the revised SSZ Map of the Landers quadrangle. Additional fractures reported by Rasmussen and Associates appear to be minor, isolated features that are could be related to secondary shaking rather than surface fault rupture (Figures 2c, 2d, and 2e).

RECOMMENDATIONS

Revise the SSZ Map of the Landers quadrangle to depict the additional fault rupture mapping of Lettis and Associates (1993) as shown on Figure 3a. Traces mapped by Lettis and Associates shown on Figure 3a are generalized due to differences in map scale and drafting pen weights used on the Official Special Studies Zones Maps.

Revise the SSZ Maps of the Landers and Yucca Valley North quadrangles to depicted selected fractures mapped by Rasmussen and Associates (1993) along the Johnson Valley fault, Fault Zone A, and Homestead Valley faults as shown on Figures 3a and 3b.

Reviewed & approved
Earl W. Hart
5/25/93

William A. Bryant
Associate Geologist
CEG 1554
May 27, 1993

REFERENCES

Bryant, W.A., 1992, Surface fault rupture along the Johnson Valley, Homestead Valley, and related faults associated with the M_s 7.5 June 1992 Landers earthquake: Division of Mines and Geology Fault Evaluation Report FER-234 (unpublished).

California Division of Mines and Geology, 1993a, Preliminary Special Studies Zones Map of the Landers Quadrangle, scale 1:24,000.

California Division of Mines and Geology, 1993b, Preliminary Special Studies Zones Map of the Yucca Valley North Quadrangle, scale 1:24,000.

I.K. Curtis Services, 1992, Aerial photographs 92-1177, 3A-28 to 31, 4-32 to 42, 5-42 to 54, 6-55 to 76, 7-77 to 94, 8-95 to 103, 9-104 to 108, 25-292 to 298, 26-299 to 306, low sun angle, black and white, vertical, scale 1:6,000.

I.K. Curtis Services, 1992, Aerial photographs Z26P-267-92 6-5 to 18; 7-1 to 18; 8-1 to 18; 9-1 to 15, vertical low sun angle, black and white, scale 1:4,000.

William Lettis and Associates, 1993, Ground rupture near Landers, CA from the 1992 Landers earthquake: Unpublished mapping for Pacific Gas and Electric, scale 1:6,000.

Rasmussen, G.A. and Associates, 1993, Letter to Earl Hart/DMG re. "Comments on proposed Alquist-Priolo Special Studies Zones in Landers area", March 29, 1993, 3p., enclosures.

Treiman, J.A., 1993, Eureka Peak and related faults, San Bernardino and Riverside Counties, California: Division of Mines and Geology Supplement No. 1 to FER-230, 3p.

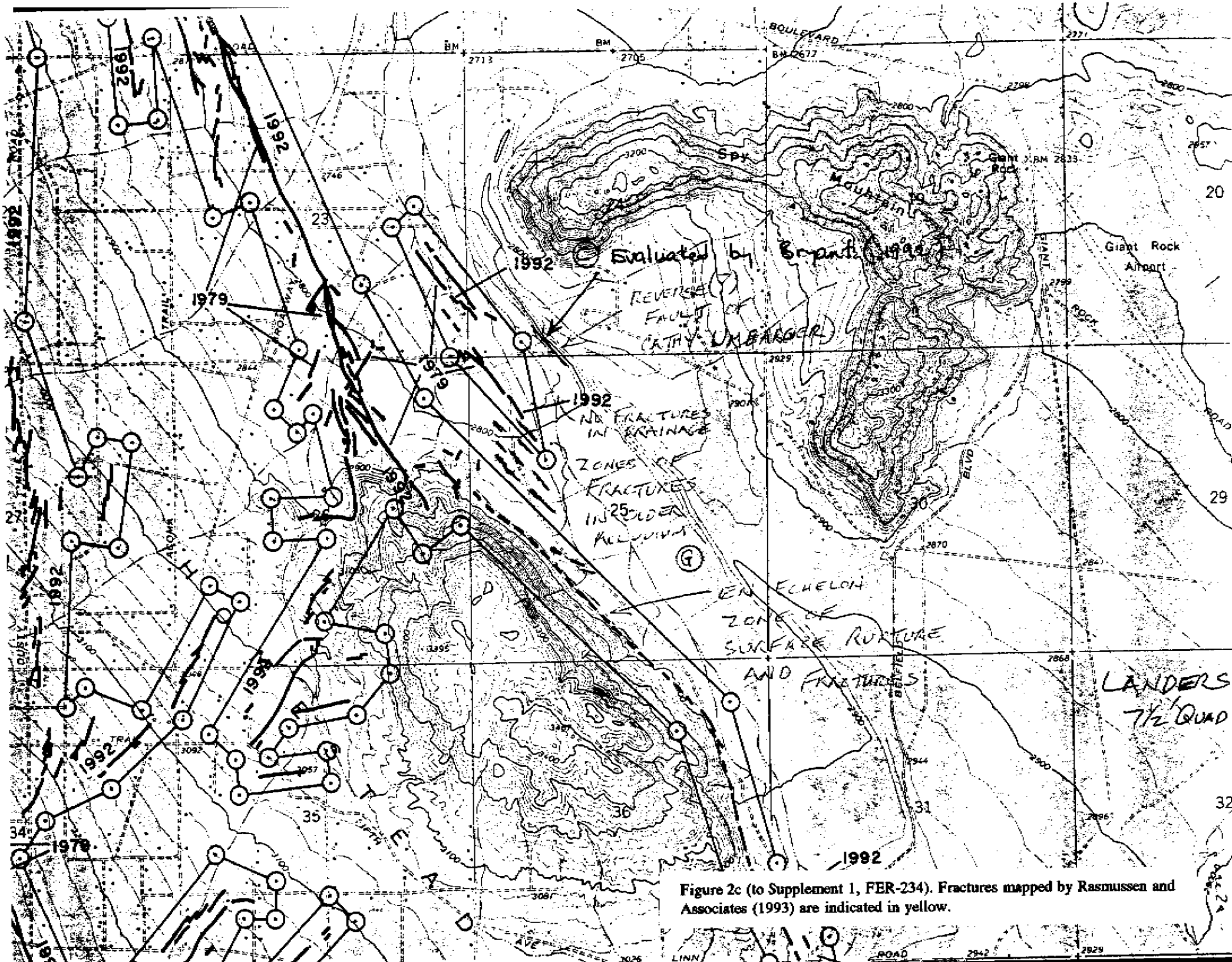

Figure 2c (to Supplement 1, FER-234). Fractures mapped by Rasmussen and Associates (1993) are indicated in yellow.

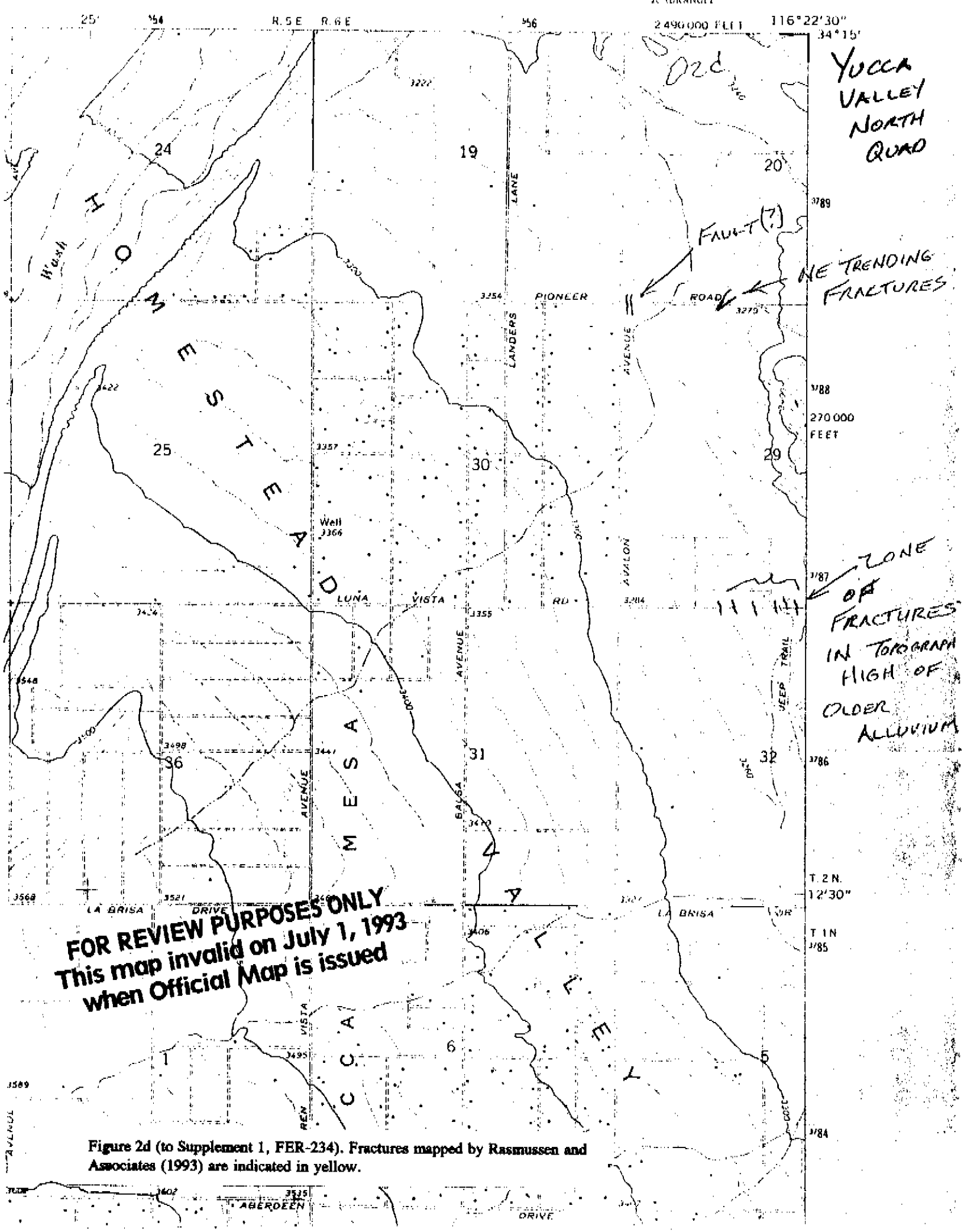

Figure 2d (to Supplement 1, FER-234). Fractures mapped by Rasmussen and Associates (1993) are indicated in yellow.